Pearson Edexcel Level 3 Certificate

Tuesday 4 June 2024

Afternoon (Time: 1 hour 40 minutes)

Paper reference **7MC0/01**

Mathematics in Context

PAPER 1: Comprehension

Source Booklet

Do not return this Booklet with the question paper.

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Formulae sheet

There will be no credit for anything you write on this formulae sheet.

Mean of a frequency distribution $= \dfrac{\sum fx}{\sum f}$

Mean of a grouped frequency distribution $= \dfrac{\sum fx}{\sum f}$, where x is the mid-interval value

Variance $= \dfrac{\sum (x - \bar{x})^2}{n}$

Standard deviation (set of numbers) $\sqrt{\left[\dfrac{\sum x^2}{n} - \left(\dfrac{\sum x}{n}\right)^2\right]}$

or $\sqrt{\left[\dfrac{\sum (x - \bar{x})^2}{n}\right]}$

where $\bar{x}$ is the mean of the set of values

Standard deviation
(discrete frequency distribution) $\sqrt{\left[\dfrac{\sum fx^2}{\sum f} - \left(\dfrac{\sum fx}{\sum f}\right)^2\right]}$

or $\sqrt{\left[\dfrac{\sum f(x - \bar{x})^2}{\sum f}\right]}$

Spearman's rank correlation coefficient $1 - \dfrac{6\sum d^2}{n(n^2 - 1)}$

The product moment correlation coefficient is

$$r = \frac{S_{xy}}{\sqrt{S_{xx}S_{yy}}} = \frac{\sum x_i y_i - \frac{\left(\sum x_i\right)\left(\sum y_i\right)}{n}}{\sqrt{\left(\sum x_i^2 - \frac{\left(\sum x_i\right)^2}{n}\right)\left(\sum y_i^2 - \frac{\left(\sum y_i\right)^2}{n}\right)}}$$

The regression coefficient of y on x is $b = \frac{S_{xy}}{S_{xx}}$

Least squares regression line of y on x is $y = a + bx$ where $a = \bar{y} - b\bar{x}$

Arithmetic series

$$u_n = a + (n - 1)d$$

$$S_n = \frac{1}{2}n(a + l) = \frac{1}{2}n[2a + (n - 1)d]$$

Geometric series

$$u_n = ar^{n-1}$$

$$S_n = \frac{a(1 - r^n)}{1 - r}$$

$$S_\infty = \frac{a}{1 - r} \text{ for } |r| < 1$$

There will be no credit for anything you write in this source booklet.

SECTION A: BEES

Data source A

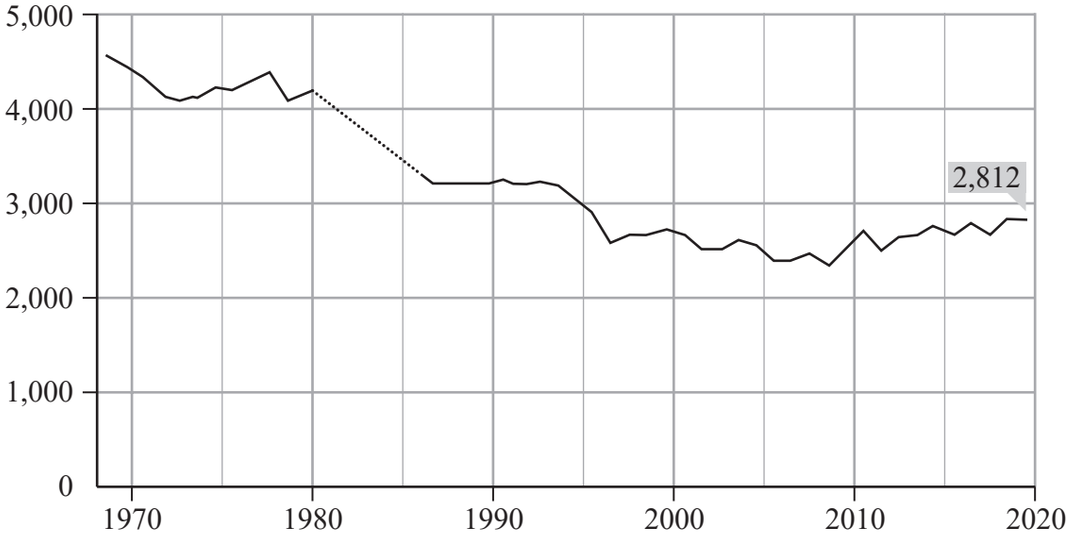
Will The Murder Hornet Accelerate the Honey Bee's Decline?

The Asian giant hornet, also known as the "murder hornet", has arrived in the United States. Nearly two inches long, the species is the world's largest wasp and it has been observed in Washington State.

The honey bee population is already in decline as the infographic below illustrates. Back in 1968, there were 4.5 million honey-producing bee colonies and that declined to around 2.8 million in 2019 (no data was recorded in the period from 1980 to 1985).

The Asian giant hornet is a voracious predator and a large group of them can destroy an entire colony of native honey bees, with an average size of 60 000, in just 90 minutes. Just one hornet can kill 40 bees per minute. If the spread is not contained, there are serious fears that the invaders will decimate America's pollinators.

Figure 1: Number of honey-producing bee colonies in the US, in thousands, by year from 1968 to 2019



No data on colony numbers were recorded for 1980-1985.

Data source B

The Bee Informed Partnership (https://beeinformed.org) is a non-profit organisation that works alongside beekeepers to improve honey bee colony health and survivorship across the United States. One of the organisation's longest running programs, the National Colony Loss and Management Survey was initiated in 2007. Since then, it has monitored managed honey bee colony loss rates, and identified risk factors and protective measures associated with beekeeping management.

A total of 3,347 beekeepers from the United States that collectively managed 192,384 colonies on 1 October 2020 provided validated survey responses. This represented 7% of the estimated 2.71 million managed honey-producing colonies in the country in 2020 (USDA NASS, 2021).

Every year, participants are asked to report what level of winter loss they would consider acceptable. The October 2020 survey concluded that a winter loss of 23.3% was an acceptable level.

Some states did not contribute to the survey.

Table 1: Summary of the percentage of managed bee colonies lost in 42 US states during winter 2020/2021

Percentage of colonies lost (p%)	Number of states
$20 < p \leqslant 30$	9
$30 < p \leqslant 40$	16
$40 < p \leqslant 50$	14
$50 < p \leqslant 60$	3
Total	42

Data source C

Managed honey bees are the most valuable pollinators and are an essential link in agriculture. Animal pollinators, especially bees, are critical for producing more than one-third of US food products. In fact, bee-pollinated products account for $20 billion in annual US production and $217 billion worldwide in 2021.

Managed bee colonies are transported to help pollinate crops around the US and the by-product of honey adds value and worth to beekeepers. Pollination income for 2021 was $269 million, up 6% from 2020. Other income from honey bees in 2021 was $102 million, up 82% from 2020.

Table 2: Total number of managed bee colonies and honey yield per colony for 42 US states 2010 to 2021

Year	Number of managed honey producing colonies (thousands)	Honey yield per colony (pounds)
2010	2692	65.6
2011	2491	59.6
2012	2624	56.1
2013	2640	56.6
2014	2740	65.1
2015	2660	58.9
2016	2775	58.3
2017	2669	55.3
2018	2803	54.4
2019	2812	55.8
2020	2706	54.5
2021	2696	46.9

Table 3: Summary of the average honey yield per managed colony for a sample of 2700 colonies in the US in 2021

Honey yield per colony (pounds)	Number of colonies
$20 < p \leqslant 30$	100
$30 < p \leqslant 40$	700
$40 < p \leqslant 50$	650
$50 < p \leqslant 60$	1200
$60 < p \leqslant 70$	50

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Please turn over for source data for Section B.

SECTION B: RETAIL INDUSTRY

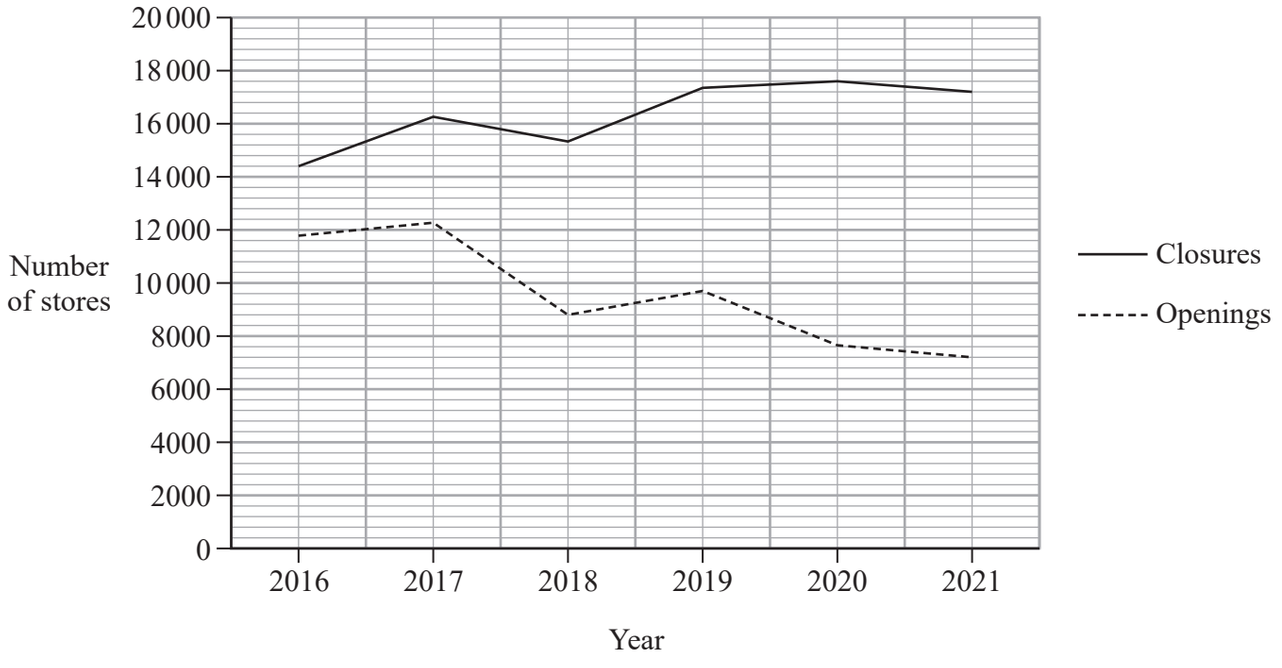
Data source D

More than 17 000 chain store shops closed last year

More than 17 000 chain store outlets closed across Britain in 2021, according to new research.
The figures, compiled for the accountancy firm PwC, reflect the rise of online shopping.
However, the data suggests the rate of closures is slowing as more independent firms take on space.
"The worst could now be over," said the head of consumer markets at PwC.

As the chart below shows, there was a slight reduction in the number of chain store closures last year, with 17 219 stores closing in 2021.
But there was also another sharp drop in the number of openings, with 7160 stores opening in 2021, which led to a net loss of 10 059 outlets, the biggest fall since 2014.

Figure 2: Chain store openings and closures 2016 to 2021



The need for more online shopping has accelerated the changes already under way across retail, causing upheaval for many high streets and town centres.
It's not the death of the high street but rather a final shake-out of some of the heritage brands.

Meanwhile, some locations continue to do better than others.
Yet again, retail parks, clusters of large stores often on the edge of town, have proved to be the most resilient.
They've become more popular with shoppers recently thanks to easier access and parking. In contrast, shopping centres have gone from being the most popular retail locations in 2015 to the worst performing over the last two years.

Figure 3: Total number of chain store openings and closures in 2021 by location

Multiple retailers/chains with more than five outlets

(Source: PwC data compiled by Local Data Company for 2021 across GB. BBC)

Data source E

Table 4: Mean average amount spent per person online buying goods for 19 European countries (nearest whole £) in 2021

Country	Average online spend (£)
Austria	1629
Belgium	1335
Czech Republic	649
Denmark	2981
Finland	2370
France	1567
Germany	1332
Greece	1061
Hungary	383
Italy	1102
Netherlands	1532
Norway	2488
Poland	471
Portugal	1135
Slovakia	300
Spain	1056
Sweden	1382
Switzerland	1915
UK	3297

Table 5: Online sales revenue as a percentage of total retail sales revenue for the UK 2010 to 2021

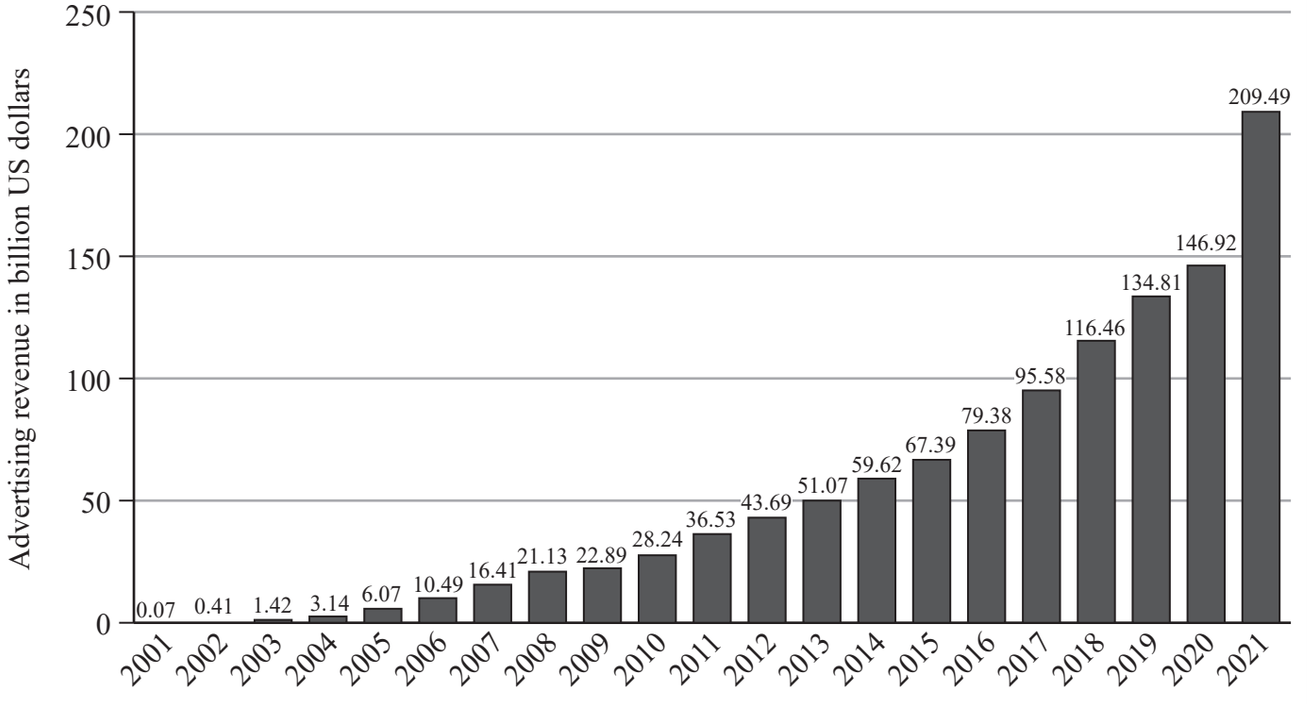
Year	Actual percentage
2010	7.4
2011	8.5
2012	9.5
2013	10.3
2014	11.2
2015	12.8
2016	14.9
2017	16.5
2018	17.8
2019	19.1
2020	24.7
2021	31.02

Data source F

Table 6: Sales revenue and advertising spend for different store types in 2021

Store type	Sales revenue ($1 000 000 000)	Advertising spend ($1 000 000)
Hobby, toy and games	5.9	180
Computer	6.0	90
Furniture	6.1	190
Jewellery	8.1	530
Shoe	16.9	460
Women's clothing	17.2	600
Home furnishings	20.2	1100
DIY	33.2	420
Electronics	53.4	1010
Department	59.8	2150
Family clothing	117.6	2920
Health and beauty	456.2	1200

Figure 4: Google's advertising revenue from 2001 to 2021



Source information

Data source A adapted from:
https://www.statista.com/chart/21600/honey-producing-bee-colonies-in-the-us/

Data source B adapted from:
https://beeinformed.org/2021/06/21/united-states-honey-bee-colony-losses-2020-2021-preliminary-results/

Data source C adapted from:
https://www.statista.com/statistics/593611/us-average-prices-honey/
https://www.beeculture.com/u-s-honey-industry-report-2021/

Data source D adapted from:
https://www.bbc.co.uk/news/business-60418435
https://www.pwc.co.uk/press-room/press-releases/store-openings-and-closures.html

Data source E adapted from:
https://merchantmachine.co.uk/cyber-shopping/
https://www.statista.com/statistics/825461/proportion-of-retail-sales-made-online-great-britain-total/

Data source F adapted from:
http://www.rab.com/research/10014.pdf
https://www.statista.com/statistics/266249/advertising-revenue-of-google/